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Description

The invention relates to compressable fluid type spring devices for vehicles, but more particularly, the invention relates to airsprings of the type with a flexible type rubber sleeve with a rolling lobe portion.

Rolling lobe type airsprings are well known in the art and are made with a sleeve having a chamber portion connected to a closure member and an inverted rolling lobe portion connected to a piston that partially reciprocates in the chamber portion of the sleeve. The general formula for calculating spring rate of such an airspring is well known and documented such as in U.S. Patent No. 4,629,170. In general, the spring rate of a conventional airspring can be represented by the following equation:

$$K = \frac{nPA_e^2}{V} + \frac{PgdAe}{dH}$$

WHERE:

K = spring stiffness

P = absolute internal pressure

Pg = gauge pressure

A_e = effective area acted on by air pressure

V = air volume

n = ratio specific heats for air

$\frac{dA_e}{dH}$ = change in effective area with spring height

An airspring is a load support member that utilizes the compressable characteristics of air for a springing effect. From the foregoing equation it is seen that spring rate may be changed by altering the pressure in the airspring, but the corresponding change in spring rate also changes the load carrying capability of the airspring. Another conventional manner for changing the spring rate of an airspring is to change the effective area that is acted on by the internal pressure of the spring. This is done by altering the external shape of the piston which laterally supports part of the rolling lobe portion of the sleeve. There is no change in effective area or spring rate if the piston is straight sided or cylindrical. However, a reduced effective area is achieved by a frustoconically shaped piston that reduces in size as it enters the chamber portion; and an increase in spring rate is achieved by a frustoconically shaped piston whose effective area increases as it enters the chamber portion.

Another method for changing the effective spring rate of an airspring is to increase its volume by increasing the inflated cylindrical diameter of the sleeve portion or to increase the inflated cylindrical length of the sleeve; both methods substantially affect the space envelope of the airspring. An increase in the inflated diameter also has the effect of increasing spring rate by an attendant increase in effective area. Of course, spring rate can also be influenced with the use of external volume reservoirs to increase volume and thereby reduce spring rate.

As a practical solution, spring rates for any particular automotive application are more easily and economically adjusted by varying the contour of the piston because of its direct effect on effective area. Increasing the cylindrical diameter of the sleeve per se to change volume and reduce spring rate becomes impractical because an increase in diameter increases the effective area which operates to further increase spring rate. Increasing the length of a sleeve to increase volume while maintaining effective area becomes impractical because it substantially affects the height of the airspring while also increasing its tendency to buckle. An example of a sleeve with a contoured piston that affects spring rate is shown in Canadian patent 1,125,319. An example of an airspring having a sleeve with increased length and a contoured piston is shown in U.S. patent 4,174,827.

In practice, the effects on spring rate caused by a piston entering and exiting an air chamber of a rolling lobe pneumatic spring, are routinely compromised by external means such as external volume reservoirs, pressure relief mechanisms, and pumps that affect pressure and volume; piston effects on spring rate are routinely compromised by internal means such as piston contour and secondairily, by sleeve length and sleeve diameter. An increase in length to increase volume has the disadvantage of increasing height and thereby decreasing buckling resistance, while an increase in diameter to increase volume has the disadvantage of increasing spring rate by increasing the effective area. The combined effects of length and diameter of an inflated cylindrical sleeve establish an optimum spring rate for a given space envelope and load. Consequently, contouring a piston has become susbstantially the only internal means for compromising piston effects on spring rate.

Sleeves for airsprings are usually of the elastomeric type, such as disclosed in DE-A-2905791 and FR-A-1466462, that are reinforced with successive layers of fibrous members oriented at opposite helical angles with respect to the sleeve; the fibrous members may be in the form of helically disposed cords being oriented at a constant angle except the attachment area of the sleeve where the cords are oriented at inconstant angles. There is no explanation in the above specifications that the cords can be wound at inconstant angles in either the rolling lobe portion or the chamber portion. An example of making a rolling lobe type sleeve is disclosed in U.S. patent 3,666,598 where uncured extruded elastomeric tubing is slipped over a thin walled mandrel forming a liner. Rubberized cord fabric, cut in the form of a parallelogram, is helically wound over the liner in one direction. A second layer of rubberized cord fabric is wound in the opposite direction over the first layerd cord fabric at substantially the same, but opposite, helical angle. A cover is applied over the cord and the assembly is cured.

The sleeve is reinforced with successive layers of embedded cords that are disposed at opposite helical angles of about 36 degrees. After the sleeve is attached to a piston and an end enclosure, it is pressurized which "pantographs" the successive layers of cord to usually a larger helical angle that approaches a locking helical angle of about 66 degrees; the increase in angle causes the sleeve to increase in diameter at the chamber portion of the sleeve.

In some methods of making a sleeve, a frustoconical mandrel is inserted into a portion of the sleeve and cured thereon so that the chamber portion of the sleeve has a larger diameter to facilitate attachment to an end closure member. The frustoconical mandrel has the effect of altering the helical angle of the cord while also changing the cord spacing; when inflated, such sleeves inflate to form substantially a cylindrical member.

In accordance with the invention, a sleeve, airspring and method are provided. The sleeve has a construction that can be used as an internal means to compromise the effects of spring rate associated with a piston entering and exiting an air chamber. Also, the effective spring rate of an airspring can be increased or reduced over that known for the inflated cylindrical type airspring.

According to the present invention there is provided an airspring comprising a sleeve, having (1) a chamber portion and (2) a rolling lobe portion intermediate ends connected to closure members, and a piston wherein the sleeve is of the elastomeric type reinforced with successive layers of embedded cords disposed at opposite helical angles, characterised in that

the cords in each of the successive layers are wound at inconstant helical angles in an annular band portion of one of the sleeve portions from first opposite helical angles to second opposite helical angles.

According to another aspect of the invention there is provided an airspring sleeve, having a chamber portion interconnecting a rolling lobe portion intermediate end portions, of the elastomeric type reinforced with successive layers of embedded cords wound at opposite helical angles, characterised in that

the cords of successive layers are wound at inconstant helical angles in an annular band portion of one of the sleeve portions from first opposite helical angles to second opposite helical angles.

The present invention also provides a method of making an airspring sleeve by embedding successive layers of cord at opposite helical angles in an elastomer and forming a chamber portion and a rolling lobe portion intermediate end portions, characterised by the step of:

winding cord of successive layers at inconstant helical angles in an annular band of one of the sleeve portions from first opposite helical angles to second opposite helical angles.

Further, the invention provides a method of influencing spring rate of an airspring comprising a sleeve having (1) a chamber portion and (2) a rolling lobe portion intermediate end portions, and a piston, wherein the sleeve is of the elastomeric type reinforced with successive layers of embedded cords disposed at opposite helical angles, the method being characterised by the steps of:

winding cord of successive layers at inconstant helical angles in an annular band portion of one of the sleeve portions from a first helical angle to a second helical angle where the difference between first and second angles is greater than five degrees and less than twentyfive degrees; and

contouring an inflated shape of the airsleeve by means of the annular band and thereby influencing the spring rate of the airspring.

Specific embodiments of the present invention are now described, by way of example only, with reference to the accompanying drawings, in which:

Figure 1 is a partially cutaway side view of a prior art sleeve for an airspring showing a helical orientation of embedded cords;

Figure 2 is a chart showing the helical angle of successive layers of cord fabric as embedded throughout the length of the prior art sleeve of Figure 1;

Figure 3 is an axial cross section of an airspring of the rolling lobe type utilizing the prior art sleeve of Figure 1;

Figure 4 is a side view similar to Figure 1 but showing a sleeve of the invention;

Figure 5 is a view similar to Figure 2 but showing the helical angle of successive layers of cords as embedded throughout the length of the sleeve of Figure 4;

Figure 6 is a view similar to Figure 3 but showing a cross section of an airspring using the sleeve of Figure 4;

Figure 7 is an enlarged and partially cutaway view taken generally along the line 7-7 of Figure 4 and showing successive layers of embedded cord wound at constant and inconstant helical angles;

Figure 8 is a side view similar to Figure 4 but showing an alternate form of a sleeve of the invention;

Figure 9 is a view similar to Figure 5 but showing the helical angle change of the sleeve of Figure 8;

Figure 10 is a view similar to Figure 6 but showing the sleeve of Figure 9 as part of an airspring.

Figure 11 is a view similar to Figure 4 but showing an alternate form of a sleeve of the invention;

Figure 12 is a view similar to Figure 5 but showing the helical angle change of the sleeve of Figure 11;

Figure 13 is a view similar to Figure 6 but showing the sleeve of Figure 12 as part of an airspring;

Figure 14 is a view similar to Figure 4 but showing an alternate form of a sleeve of the invention;

Figure 15 is a view similar to Figure 5 but showing the helical angle change of the sleeve of Figure 14;

Figure 16 is a view similar to Figure 6 but showing the sleeve of Figure 14 as part of an airspring;

Figure 17 is a schematical side view of a lathe showing how successive cord layers may be wound at inconstant helical angles in accordance with a method of the invention;

Figure 18 is a side view of successive sleeves built end-to-end such as with the lathe of Figure 17;

Figure 19 is a view similar to Figure 5 but showing the helical angle of successive layers of cords as embedded throughout the sleeves of Figure 18; and

Figure 20 is a chart showing comparative load and pressures for airsprings built in accordance with Figures 3 and Figure 6.

Figures 1-3 illustrate some characteristics of a prior art sleeve and airspring for comparing to characteristics of the present invention. In Figure 1, a conventional prior art sleeve 10 of the cylindrical type is shown. The sleeve is of the elastomeric type that is reinforced with successive layers 12, 14 of embedded cords disposed at opposite helical angles H, H' The sleeve has a chamber portion A-B interconnecting a rolling lobe portion B-C. Figure 2 illustrates the opposite helical angles that are used relative to axial position for the successive layers of cord. A helical angle H, H' of about 30 degrees is shown for each of the successive cord layers (for the purpose of this disclosure, there are no plus or minus signs used to show the opposite helical angles); however, it is known in the art that a helical angle in a range of about 30 to about 55 degrees may be used throughout the sleeve for both the chamber portion A-B, and the rolling lobe portion B-C.

When used in an airspring 16 such as that disclosed in Figure 3, the rolling lobe portion B-C of the sleeve 10 is inverted and connected at an end 18 to a piston 20 and the chamber portion A-B is connected at an end 22 to a closure member 24. The dotted line 26 illustrates how the piston and rolling lobe portion moves into the chamber portion when the airspring is pressurized. Pressurization causes the helical angle of the cords to change (not shown) and approach what is known as the "locking angle" which is about 66 degrees. As the cords change angle, they also change position or "pantograph" relative to each other permitting the sleeve to expand to a substantially cylindrical shape having a diameter 28 that is greater than the original diameter 30. In some prior art sleeves, an end portion of a sleeve is slid over a frustoconical mandrel (not shown) so that the end portion is more easily attachable to a closure member; however, such sleeves also inflate to substantially a cylindrical shape owing to the helical orientation and circumferential spacing of the cords.

Referring to Figures 4 - 7, a sleeve 32 is provided for use on an airspring 34 of the invention. The sleeve 32 is of the elastomeric type that may be compounded with any suitable elastomer such as rubber, synthetic rubber, or blends thereof, urethanes, or the like. The sleeve is reinforced with an embedded fibrous member such as cords 36 where successive layers 38, 40 of cord are wound at opposite helical

angles J-J', K-K'. The fibrous member or cords may be of any suitable type such as made with synthetic fibers of nylon, rayon, polyester, fiberglass and aramid, or the cord may be made of natural fibers such as cotton or the like. The elastomeric portion of the sleeve forms a liner 42, a cover 44, and optionally, a layering between successive layers of cord. The sleeve has a chamber portion A-B interconnecting a rolling lobe portion B-C. Throughout this disclosure, the letters A-B are used to designate a chamber portion and the letters B-C are used to designate a rolling lobe portion to facilitate an easy comparison of such portions in the various examples. Cords of successive layers 38,40 are wound at inconstant helical angles 48 in at least one annular band portion B-D of either the rolling lobe portion B-C as shown juxtaposed the chamber portion or in the chamber portion per se. The angles are inconstant and vary from first opposite helical angles J-J' to second opposite helical angles K-K'. As particularly illustrated in Figure 7, the change in helical angles in the band portion puts a "partial loop" 50 in the cords with an attendant increase in length over that of a cord wound at a constant helical angle. As illustrated in Figure 4, the helical angle J-J' changes from about 45 degrees in the chamber portion to a helical angle K-K of about 30 degrees in the rolling lobe portion. The axial length of the band portion where the inconstant helical angles occur is preferably about 1.27cm (0.5 in), and more preferably is at least about 2.54cm (1 inch); but the axial length may vary over the entire rolling lobe portion, the entire chamber portion or both. Preferably, the helical angles in the rolling lobe portion are less than that of the 66 degree locking angle of a sleeve when pressurized. For example, the helical angles may preferably range from about 30 to about 62 degrees in the rolling lobe portion and more preferably from about 35 degrees to about 55 degrees; and most preferably, from about 38 degrees to about 55 degrees. In the chamber portion, the helical angles may preferably range from about 10 to about 89 degrees, more preferably from about 20 to about 70 degrees and most preferably from about 30 to about 60 degrees.

When the sleeve 32 is assembled as a component part of the airspring 34 as particularily illustrated in Figure 6, an end 52 of the chamber portion is connected to a closure member 54 with attachment means such as a band 56, and the rolling lobe portion is inverted and connected at an end 58 by attachment means such as a band 56, to a piston 60. The piston primarily reciprocates in the chamber portion as illustrated by the dotted line. The piston is shown to have a cylindrical contour but it may also include upright or inverted frustoconical sections as known in the art to further affect spring rate.

The airspring is inflated causing the cords to change their helical angle and approach the locking angle. The "partial loop" 50 in the cords of the band portion B-D substantially "straighten out" and also pantograph as they approach a locking angle. The position change of the cords in the band portion makes a transitionary section between a larger inflated diameter 62 of the rolling lobe and a smaller inflated diameter 64 of the chamber portion. The rolling lobe portion with its cord wound at a smaller helical angle (i.e. 30 degrees) that is less than the locking angle (i.e. 66 degrees), inflates to a larger diameter than the chamber portion where the cords are at a larger helical angle (i.e. 45 degrees) that is also less than the locking angle. The maximum diameter 62 of the rolling lobe corresponds to the maximum effective area diameter of the pressurized airspring. When the piston 60 enters the chamber as shown by the dotted line, the larger diameter portion associated with part D-C of the rolling lobe inverts and rolls against the piston and thereby subtracts its increased diameter and area; the result is that spring rate is reduced from the effect of the piston entering the chamber. Accordingly, the annular band with its inconstant helical angle defines a means for decreasing the effective spring rate of the airspring.

One or more bands with cords at inconstant helical angles may be wound in a sleeve for the purpose of controlling the inflated contour of the airspring. In the foregoing example (Figures 4-7), a cylindrical sleeve is constructed in accordance with the invention to have a non-cylindrical inflated contour to increase effective area. Referring to Figures 8-10, a sleeve 66 similar to that for Figure 4 is provided except that a second annular band portion E-B with inconstant helical angles 68 is located in the chamber portion A-B juxtaposed the rolling lobe portion of the first band portions B-D. As illustrated in Figure 9, the helical angle of the cords of successive layers are wound from a first angle L-L' of about 30 degrees to a second angle M of about 45 degrees and back to a third angle N-N' of about 30 degrees. Like in the previous example, the helical angles may be as desired but usually are chosen to be less than the locking angle of 66 degrees. When assembled in an airspring 70 such as in the manner previously described, one end 72 of the chamber portion is attached to a closure member 74 and the rolling lobe portion of the sleeve is inverted and attached at an end 76 to a piston member 78. When the airspring is inflated, the first band portion B-D, with its inconstant helical angles, control an inflated portion of the rolling lobe to an increased diameter 80 and thereby cause an increase in effective area; the second band B-E of inconstant helical angles or angle gradient makes a transitionary change to an increased diameter 82 of the chamber portion which increases airspring volume. The effect is to lower the overall height of the airspring without increasing its spring rate.

To partialy illustrate the effectiveness of the sleeve and airspring of the invention, two airsprings were built having the construction substantially in accordance with Figures 6 and 10 for comparison with a similarly sized prior art airspring constructed to support a nominal load of approximately 1200 pounds. The following table illustrates the reduced spring rate and height associated with the teachings of the inventions:

Variable (at Design Height)	Figure 3 Prior Art	Figure 6	Figure 10
Design Height (cm(in))	24.13 (9.50)	23.50 (9.25)	19.05 (7.50)
Load (kg(lbs))	521.16 (1150)	521.6 (1150)	521.6 (1150)
Pressure (kNm^{-2} (psi))	503 (73)	503 (73)	503 (73)
Rolling Lobe Diameter (cm(in))	14.5 (5.7)	14.5 (5.7)	14.5 (5.7)
Piston Diameter (cm(in))	9.9 (3.9)	9.9 (3.9)	9.9 (3.9)
Piston Type	Straight	Straight	Straight
Volume (cm^3 (in^3))	1721 (105)	1721 (105)	1721 (105)
Spring Rate (kg/cm(lb/in))	52. 5 (294)	39.3 (220)	39.3 (220)

Figures 11 through 13 are illustrative of another embodiement of the invention where a sleeve 84 made in a manner similiar to that as previously described is shown. However, the sleeve 84 has band portions H-G, B-F with inconstant helical angles and one portion 6B with constant helical angle R-R' that control the inflated contour of the air sleeve. The inconstant helical angles are varied through transients in accordance with Figure 12 from first angles P-P', to second angles R-R', to third angles S-S'. The sleeve is assembled into an airspring 86 in a manner as previously described except that the airspring also has a center strut 88 such as may be used in some types of suspension members. When inflated, the airspring has a toroidal portion 89 with an increased diameter 90 causing an attendant increase in volume and a band B-F portion in the rolling lobe portion which controls and increases the effective diameter 92, and consequently the effective area, at the nominal height position.

The previous teachings of the invention are associated with building a sleeve having an inflated cylindrical diameter and a contoured inflated diameter. Teachings of the invention of using inconstant helical angles may also be used when forming any sleeve having an uninflated shape such as being frustoconical. Referring to Figures 14-16, another embodiement of the invention is shown. A sleeve 94 is provided where the sleeve is made with an elastomeric material and has embedded successive layers of cord wound at helical angles T-T' in accordance with Figure 12 so that the band A-C is located substantially throughout the chamber and rolling lobe portion of the sleeve. The cord is wound at predetermined inconstant helical angles in the band portion such that when the sleeve is assembled into an airspring 96 such as shown in Figure 16 and inflated, it substantially remains in a frustoconical shape. If the inconstant helical angles in the band were not controlled, it would inflate to a cylindrical shape at a locking angle of about 66 degrees.

Method

Sleeves of the invention may be made on a lathe 97 such as is illustrated in Figure 17 having a spindle 98 and carriage 100 that may be varied in speed with respect to each other. A mandrel 102 is chucked in the lathe and successive layers of a sleeve are applied thereto. Layers of elastomeric material may be applied in known fashion such as by extruding, spiraling, lapping or the like. The purpose of Figure 17 is to show a methodolgy of how successive layers of cord 104 may be wound at inconstant helical angles utilizing a cord let-off ring 106. Rotation of the lathe and movement of the carriage are reversed for successive cord layers. For a constant helical angle built on a constant diameter mandrel, the mandrel rotational velocity and carriage velocity remain at a fixed constant such as is used in standard lathe equipment. However, if the helix angle is to be varied along the sleeve axis with respect to the mandrel, a new velocity relationship is required. For increases in helix angle, the ratio of carriage velocity to mandrel

velocity is decreased. For decreases in helix angle, rotation of carriage velocity to mandrel velocity is increased. To continually vary a helix angle from some initial value to some final value over a given distance along the mandrel axis, carriage velocity and mandrel velocity must be constantly controlled such as by means such as computers (not shown) and stepper motors 108, 110.

Referring to Figure 18, successive sleeves 114, 116 are built end-to-end on a single mandrel with the lathe. As an example, a series of sleeves are built with the configuration as illustrated with regard to Figure 9 and in accordance with the helical angle variation T-T' illustrated by Figure 19. Once built and thereafter cured in known fashion such as for example as those used to cure lengths of hose, successive sleeves 112, 114, 116 are cut 118 therefrom.

To further illustrate the effectivness of sleeves and airsprings of the invention, Figure 20 shows airspring load versus deflection and pressure versas deflection curves for sleeves of Figure 3 and Figure 6. As shown, the airspring of the invention has lower load and pressure change for a given deflection and consequently, a lower spring rate than the prior art airspring. Thus, the sleeve with its band portion of inconstant helical angles is used as an internal means for controlling spring rate to compromise the effects of a piston entering and exiting a chamber. Heretofore, sleeves were not used as an internal means to effectively control or substantially modify spring rate; contoured pistons were used.

Claims

1. An airspring (34,70,86,96) comprising a sleeve (32,66,84,94), having (1) a chamber portion (A-B) and (2) a rolling lobe portion (B-C) intermediate ends (52,72;58,76) connected to closure members (54,74;60,78), and a piston (60,78), wherein the sleeve is of the elastomeric type reinforced with successive layers (38,40) of embedded cord (36) disposed at opposite helical angles (J-J', K-K'), characterised in that:
   the cords (36) in each of the successive layers (38,40) are wound at inconstant helical angles (48) in an annular band portion (B-D,E-B,H-G,B-F) of one of the sleeve portions (A-B,B-C) from first opposite helical angles (J-J',L-L',M, P-P', R-R', T) to second opposite helical angles (K-K', M,N-N', R-R', S-S',T') in order to establish an optimum spring rate for a given space, envelope and load.

2. An airspring as claimed in claim 1 wherein the band portion (B-D, E-B, H-G, B-F) defines a means for establishing an inflated contour of the sleeve.

3. An airspring as claimed in claim 1 or claim 2 wherein the band portion (B-D, B-F) is in the rolling lobe portion (B-C).

4. An airspring as claimed in claim 1 or claim 2 wherein the band portion (E-B, H-G) is in the chamber portion (A-B).

5. An airspring as claimed in any preceding claim further including a strut member (88) extending from an end closure member and slidably through a center portion of the piston.

6. An airspring as claimed in claim 1 wherein the cords (36) contour a band portion (B-D) of the rolling lobe portion (B-C) to an effective diameter that decreases as part of the rolling lobe portion (B-C) is rolled into the chamber portion (A-B) by means of the piston (60) to thereby decrease the effective spring rate of the airspring.

7. An airspring as claimed in claim 6 wherein the cords (36) in the rolling lobe portion (B-C) are at constant and first opposite helical angles in a range from about 30 to about 45 degrees and at a second larger angle from about 40 to about 55 degrees.

8. An airspring as claimed in claim 1 wherein the cords (36) contour a band portion (H-G) of the sleeve (84) to increase an inflated volume of the chamber portion (A-B).

9. An airspring as claimed in claim 8 wherein the cords (36) of the chamber portion (A-B) are from a first opposite helical angle in a range from about 40 to 55 degrees to lesser second helical angle in a range from about 45 to 30 degrees.

10. An airspring sleeve, having a chamber portion (A-B) interconnecting a rolling lobe portion (B-C) intermediate end portions (52,72,58,76), of the elastomeric type reinforced with successive layers (38,40) of embedded cords (36) wound at opposite helical angles (J-J', K-K') characterised in that:
the cords (36) of successive layers (38,40) are wound at inconstant helical angles (48) in an annular band portion (B-D, E-B, H-G, B-F) of one of the sleeve portions (A-B, B-C) from first opposite helical angles to second opposite helical angles in order to compromise the effects of spring rate associated with a piston entering and exiting an air chamber.

11. An airspring sleeve as claimed in claim 10 wherein the band portion (B-D, H-G, B-F) defines a means for establishing an inflated contour of the sleeve (32, 84).

12. An airspring sleeve as claimed in claim 10 wherein the band portion (E-B, H-G) is in the chamber portion (A-B) of the sleeve (66,84).

13. An airspring sleeve as claimed in claim 10 wherein the band portion (B-D, B-F) is in the rolling lobe portion (B-C).

14. An airspring sleeve as claimed in claim 13 wherein the band portion (B-D, B-F) is in the rolling lobe portion (B-C) and juxtaposed the chamber portion (A-B).

15. An airspring sleeve as claimed in any one of claims 10 to 14 wherein the band portion (B-D, E-B, H-G, B-F) has a width measured axially of the sleeve that is at least about 1.27cm (0.5in).

16. An airspring sleeve as claimed in claim 10 wherein the sleeve (32,66) is substantially cylindrical.

17. An airspring sleeve (94) as claimed in claim 10 wherein the sleeve is substantially frustoconical.

18. An airspring sleeve as claimed in any one of claims 10 to 17 wherein the absolute difference between the first and second opposite helical angles is at least about five degrees.

19. An airspring sleeve as claimed in claim 10 wherein the inconstant helical angles (48) of the band (B-D) are substantially in the rolling lobe portion (B-C) and are followed by a second (M) and opposite inconstant helical angles in a second annular band portion (E-B) substantially in the chamber portion (A-B), the opposite helical angles of the second band portion (E-B) from the second opposite helical angles (M) to third opposite helical angles (L-L').

20. An airspring sleeve as claimed in claim 19 wherein the first opposite helical angle is from about 30 to about 45 degrees , the second opposite helical angle is from about 40 to 55 degrees, and the third opposite helical angle is from about 30 to about 45 degrees.

21. An airspring sleeve as claimed in claim 10 wherein the cords (36) in each of the successive layers (38,40) are wound at a first helical angle (T) in the chamber portion (A-B) and at a second, unequal angle (T') in the rolling lobe portion (B-C).

22. An airspring sleeve as claimed in claim 21 wherein the angle in the chamber portion (A-B) is greater than the angle in the rolling lobe portion (B-C).

23. An airspring sleeve as claimed in claim 22 wherein the first helical angle (T) is in a range from about 10 to about 89 degrees and the second helical angle (T') is in a range from about 30 to about 62 degrees.

24. An airspring sleeve as claimed in claim 21 wherein the first helical angle (T) is in a range from about 20 to about 70 degrees and the second helical angle (T') is in a range from about 35 to about 55 degrees.

25. An airspring sleeve as claimed in claim 21 wherein the first helical angle (T) is in a range from about 30 to about 60 degrees and the second helical angle (T') is in a range from about 38 to about 55 degrees.

26. A method of making an airspring sleeve (32,66,84,94) by embedding successive layers (38,40) of cord (36) at opposite helical angles (J-J', K-K')in an elastomer and forming a chamber portion (A-B) and a

rolling lobe portion (B-C) intermediate end portions (52,72;58,76), characterised by the step of:
winding cord (36) of successive layers (38,40) at inconstant helical angles (48) in an annular band (B-D,E-B, H-G,B-F) of one of the sleeve portions (A-B, B-C) from first opposite helical angles (J-J', L-L', M, P-P', R-R',T) to second opposite helical angles (K-K', M, N-N', R-R',S-S', T').

27. A method as claimed in claim 26 including the step of winding the cord (36) in the band (B-D,B-F) as part of the rolling lobe portion (B-C).

28. A method as claimed in claim 26 including the step of winding the cord (36) in the band (E-B, H-G) as part of the chamber portion (A-B).

29. A method as claimed in claim 26 including the step of winding cord (36) at inconstant helical angles (48) in a second band portion (B-F) from the second opposite helical angles (R-R') to smaller, third opposite helical angles (S-S').

30. A method as claimed in claim 29 wherein the method of making the sleeve includes plying elastomeric and cord materials on a mandrel (102) and embedding successive layers of cord (104) at opposite helical angles in the elastomer, curing the sleeve and removing the mandrel (102) forming a chamber portion (A-B) and a rolling lobe portion (B-C), the method further including:
forming a series of at least two sleeves interconnected end-to-end; and
severing the series of sleeves into individual sleeves (32,66,84,94).

31. A method as claimed in claim 30 including the step of winding the cord (36) in the band as part of the rolling lobe portion (B-C) of each sleeve (32,66,84,94).

32. A method as claimed in claim 30 including the step of winding the cord (36) in the band as part of the chamber portion (A-B) of each sleeve (32,66,84,94).

33. A method of influencing spring rate of an airspring comprising a sleeve (32,66,84,94), having (1) a chamber portion (A-B) and (2) a rolling lobe portion (B-C) intermediate end portions (52,72;58,76), and a piston (60,78) wherein the sleeve is of the elastomeric type reinforced with successive layers (38,40) of embedded cords (36) disposed at opposite helical angles (J-J', K-K'), the method being characterised by the steps of:
winding cord (36) of successive layers at inconstant helical angles (48) in an annular band portion (B-D, E-B, H-G, B-F) of one of the sleeve portions (A-B, B-C) from a first helical angle (J-J', L-L', M, P-P', R-R', T)to a second helical angle (K-K', M, N-N', R-R', S-S',T') where the difference between first and second angles is greater than five degrees and less than twentyfive degrees; and
contouring an inflated shape of the airsleeve (32,66,84,94) by means of the annular band (B-D,E-B,H-G,B-F) and thereby influencing the spring rate of the airspring.

34. A method of influencing spring rate as claimed in claim 33 including the step of locating the band (B-D,B-F) in the rolling lobe portion (B-C).

35. A method of influencing spring rate as claimed in claim 33 including the step of locating the band (E-B, H-G) in the chamber portion (A-B).

36. A method of influencing spring rate as claimed in claim 33 including the steps of locating the band (B-D, B-F) in the rolling lobe portion (B-C) and adjacent the chamber portion (A-B) and winding cord (36) at inconstant helical angles from a first angle of about 40 degrees to a second angle of about 50 degrees.

37. A method of influencing spring rate as claimed in claim 33 including the steps of:
winding cord (36) of successive layers at inconstant helical angles in an annular band portion of the chamber portion (A-B) from a second helical angle of about 50 degrees to a third helical angle of about 40 degrees; and
contouring the inflated shape of the chamber portion.

est dans la partie de lobe roulant (B-C).

14. Manchon de ressort pneumatique selon la revendication 13, dans lequel la partie de ceinture (B-D, B-F) est dans la partie de lobe roulant (B-C) et juxtaposée a la partie de chambre (A-B).

15. Manchon de ressort pneumatique selon l'une quelconque des revendications 10 à 14, dans lequel la partie de ceinture (B-D, E-B, H-G, B-F) a une largeur, mesurée axialement au manchon, qui est d'au moins environ 1,27 cm (0,5 in).

16. Manchon de ressort pneumatique selon la revendication 10, dans lequel le manchon (32, 66) est sensiblement cylindrique.

17. Manchon (94) de ressort pneumatique selon la revendication 10, dans lequel le manchon est sensiblement tronconique.

18. Manchon de ressort pneumatique selon l'une quelconque des revendications 10 à 17, dans lequel la différence absolue entre les premiers et seconds angles d'hélice opposés est d'au moins environ cinq degrés.

19. Manchon de ressort pneumatique selon la revendication 10, dans lequel les angles d'hélice inconstants (48) de la ceinture (B-D) sont sensiblement dans la partie de lobe roulant (B-C) et sont suivis de deuxièmes angles d'hélice inconstants opposés (M) dans une deuxième partie de ceinture annulaire (E-B) sensiblement dans la partie de chambre (A-B), les angles d'hélice opposés de la deuxième partie de ceinture (E-B) allant des deuxièmes angles d'hélice opposés (M) à des troisièmes angles d'hélice opposés (L-L').

20. Manchon de ressort pneumatigue selon la revendication 19, dans lequel le premier angle d'hélice opposé est compris entre environ 30 et environ 45 degrés, le deuxième angle d'hélice opposé est compris entre environ 40 et 55 degrés et le troisième angle d'hélice opposé est compris entre environ 30 et environ 45 degrés.

21. Manchon de ressort pneumatique selon la revendication 10, dans lequel les câblés (36) dans chacune des couches successives (38, 40) sont enroulés à un premier angle d'hélice (T) dans la partie de chambre (A-B) et à un deuxième angle inégal (T') dans la partie de lobe roulant (B-C).

22. Manchon de ressort pneumatique selon la revendication 21, dans lequel l'angle dans la partie de chambre (A-B) est plus grand que l'angle dans la partie de lobe roulant (B-C).

23. Manchon de ressort pneumatique selon la revendication 22, dans lequel le premier angle d'hélice (T) est dans une plage d'environ 10 à environ 89 degrés et le deuxième angle d'hélice (T') est dans une plage d'environ 30 à environ 62 degrés.

24. Manchon de ressort pneumatique selon la revendication 21, dans lequel le premier angle d'hélice (T) est dans une plage d'environ 20 à environ 70 degrés et le deuxième angle d'hélice (T') est dans une plage d'environ 35 à environ 55 degrés.

25. Manchon de ressort pneumatique selon la revendication 21, dans lequel le premier angle d'hélice (T) est dans une plage d'environ 30 à environ 60 degrés et le deuxième angle d'hélice (T') est dans une plage d'environ 38 à environ 55 degrés.

26. Procédé de fabrication d'un manchon (32, 66, 84, 94) de ressort pneumatique en noyant des couches successives (38, 40) de câblé (36) à des angles d'hélice opposés (J-J', K-K') dans un élastomère et en formant une partie de chambre (A-B) et une partie de lobe roulant (B-C) entre des parties extrêmes (52, 72 ; 58, 76), caractérisé par les étapes qui consistent :

à enrouler un câblé (36) de couches successives (38, 40) à des angles d'hélice inconstants (48) dans une ceinture annulaire (B-D, E-B, H-G, B-F) de l'une des parties de manchon (A-B, B-C) allant de premiers angles d'hélice opposés (J-J', L-L', M, P-P', R-R', T) à des seconds angles d'hélice opposés (K-K', M, N-N', R-R', S-S', T').

27. Procédé selon la revendication 26, comprenant l'étape qui consiste à enrouler le câblé (36) dans la ceinture (B-D, B-F) en tant que portion de la partie de lobe roulant (B-C).

28. Procédé selon la revendication 26, comprenant l'étape qui consiste à enrouler le câblé (36) dans la ceinture (E-B, H-G) en tant que portion de la partie de chambre (A-B).

29. Procédé selon la revendication 26, comprenant l'étape qui consiste à enrouler le câblé (36) à des angles d'hélice inconstants (48) dans une seconde partie de ceinture (B-F) allant des deuxièmes angles d'hélice opposés (R-R') à des troisièmes angles d'hélice opposés, plus petits (S-S').

30. Procédé selon la revendication 29, dans lequel la fabrication du manchon consiste à appliquer par plis des matières élastomériques et de câblé sur un mandrin (102) et à noyer des couches successives de câblé (104) à des angles d'hélice opposés dans l'élastomère, à faire durcir le manchon et enlever le mandrin (102), formant une partie de chambre (A-B) et une partie de lobe roulant (B-C), le procédé consistant en outre :

à former une série d'au moins deux manchons reliés entre eux bout à bout ; et

à sectionner les séries de manchons en manchons individuels (32, 66, 84, 94).

31. Procédé selon la revendication 30, comprenant l'étape qui consiste à enrouler le câblé (36) dans la ceinture en tant que portion de la partie de lobe roulant (B-C) de chaque manchon (32, 66, 84, 94).

32. Procédé selon la revendication 30, comprenant l'étape qui consiste à enrouler le câblé (36) dans la ceinture en tant que portion de la partie de chambre (A-B) de chaque manchon (32, 66, 84, 94).

33. Procédé pour influer sur la raideur d'un ressort pneumatique comprenant un manchon (32, 66, 84, 94), ayant (1) une partie de chambre (A-B) et (2) une partie de lobe roulant (B-C) entre des parties extrêmes (52, 72 ; 58, 76), et un piston (60, 78), dans lequel le manchon est du type élastomérique renforcé avec des couches successives (38, 40) de câblés noyés (36) disposés à des angles d'hélice opposés (J-J', K-K'), le procédé étant caractérisé par les étapes qui consistent :

à enrouler un câblé (36) de couches successives à des angles d'hélice inconstants (48) dans une partie de ceinture annulaire (B-D, E-B, H-G, B-F) de l'une des parties de manchon (A-B, B-C) allant d'un premier angle d'hélice (J-J', L-L', M, P-P', R-R', T) à un deuxième angle d'hélice (K-K', M, N-N', R-R', S-S', T) où la différence entre les premier et second angles est supérieure à 5 degrés et inférieure à 25 degrés ; et

à profiler une forme gonflée du manchon pneumatique (32, 66, 84, 94) au moyen de la ceinture annulaire (B-D, E-B, H-G, B-F) et à influer ainsi sur la raideur du ressort pneumatique.

34. Procédé pour influer sur la raideur selon la revendication 33, comprenant l'étape qui consiste à placer la ceinture (B-D, B-F) dans la partie de lobe roulant (B-C).

35. Procédé pour influer sur la raideur selon la revendication 33, comprenant l'étape qui consiste à placer la ceinture (E-B, H-G) dans la partie de chambre (A-B).

36. Procédé pour influer sur la raideur selon la revendication 33, comprenant les étapes qui consistent à placer la ceinture (B-D, B-F) dans la partie de lobe roulant (B-C) à proximité immédiate de la partie de chambre (A-B), et à enrouler un câblé (36) à des angles d'hélice inconstants, allant d'un premier angle d'environ 40 degrés à un second angle d'environ 50 degrés.

37. Procédé pour influer sur la raideur selon la revendication 33, comprenant les étapes qui consistent :

à enrouler un câblé (36) en couches successives à des angles d'hélice inconstants dans une partie de ceinture annulaire de la partie de chambre (A-B), allant d'un deuxième angle d'hélice d'environ 50 degrés à un troisième angle d'hélice d'environ 40 degrés ; et

à profiler la forme gonflée de la partie de chambre.

Ansprüche

1. Luftfeder (34,70,86,96) mit einer Buchse (32,66,84, 94), mit (1) einem Kammer-Bereich (A-B) und (2)

einem Rollbalg-Bereich (B-C), die zwischen Endteilen (52, 72; 58,76) angeordnet sind, welche mit Verschlußteilen (54,74;60,78) verbunden sind, und einem Kolben (60,78), wobei die Buchse aus Elastomer besteht, das durch aufeinanderfolgende Schichten (38,40) aus eingebetteten Cords (36) verstärkt ist, welche mit gegensinnigen Schraubenwinkeln (J-J',K-K') angeordnet sind, dadurch gekennzeichnet, daß

die in jeder der aufeinanderfolgenden Schichten (38,40) befindlichen Cords (36) in einem ringförmigen Bandbereich (B-D,E-B,H-G,B-F) eines der Buchsenbereiche (A-B,B-C) mit inkonstanten Schraubenwinkeln (48), von ersten gegensinnigen Schraubenwinkeln (J-J', L-L',M, P-P', R-R',T) bis hin zu zweiten gegensinnigen Schraubenwinkeln (K-K',M, N-N',R-R',S-S',T'), gewickelt sind, um bei vorgegebenen Raum, Hüllform und Last eine optimale Federungsrate zu bewirken.

2. Luftfeder nach Anspruch 1, bei der der Bandbereich (B-D,E-B,H-G,B-F) eine Einrichtung zum Bewirken einer ausgebeulten Kontur der Buchse bildet.

3. Luftfeder nach Anspruch 1 oder Anspruch 2, bei der sich der Bandbereich (B-D,B-F) in dem Rollbalg-Bereich (B-C) befindet.

4. Luftfeder nach Anspruch 1 oder Anspruch 2, bei der sich der Bandbereich (E-B,H-G) in dem Kammer-Bereich (A-B) befindet.

5. Luftfeder nach einem der vorhergehenden Ansprüche, ferner mit einem Strebenteil (88), das sich von einem End-Verschlußteil gleitbar durch einen Mittelbereich des Kolbens erstreckt.

6. Luftfeder nach Anspruch 1, bei der die Cords (36) einen Bandbereich (B-D) des Rollbalg-Bereiches (B-C) auf einen effektiven Durchmesser konturieren, welcher, wenn ein Teil des Rollbalg-Bereiches (B-C) mittels des Kolbens (60) in den Kammer-Bereich (A-B) gerollt wird, abnimmt, um dadurch die effektive Federungsrate der Luftfeder zu verringern.

7. Luftfeder nach Anspruch 6, bei der die Cords (36) in dem Rollbalg-Bereich (B-C) mit konstanten und ersten gegensinnigen Schraubenwinkeln im Bereich von etwa 30 bis etwa 45 Grad und mit einem zweiten, größeren Winkel von etwa 40 bis etwa 55 Grad angeordnet sind.

8. Luftfeder nach Anspruch 1, bei der die Cords (36) einen Bandbereich (H-G) der Buchse (84) so konturieren, daß das ausgebeulte Volumen des Kammer-Bereiches (A-B) vergrößert wird.

9. Luftfeder nach Anspruch 8, bei der die Cords (36) des Kammer-Bereiches (A-B) von einem ersten gegensinnigen Schraubenwinkel im Bereich von etwa 40 bis 55 Grad bis hin zu einem kleineren zweiten Schraubenwinkel im Bereich von etwa 45 bis 30 Grad liegen.

10. Luftfeder-Buchse, mit einem Kammer-Bereich (A-B), der einen Rollbalg-Bereich (B-C) zwischen Endteilen (52,72;58,76) verbindet, bestehend aus Elastomer, das durch aufeinanderfolgende Schichten (38,40) aus eingebetteten Cords (36) verstärkt ist, welche mit gegensinnigen Schraubenwinkeln (J-J',K-K') angeordnet sind, dadurch gekennzeichnet, daß

die Cords (36) aufeinanderfolgender Schichten (38, 40) in einem ringförmigen Bandbereich (B-D,E-B,H-G,B-F) eines der Buchsenbereiche (A-B,B-C) mit inkonstanten Schraubenwinkeln (48), von ersten gegensinnigen Schraubenwinkeln bis hin zu zweiten gegensinnigen Schraubenwinkeln, gewickelt sind, um einen Kompromiß zwischen den Auswirkungen der Federungsrate, die mit dem Eintreten und Austreten eines Kolbens in eine Luftkammer bzw. aus dieser zusammenhängen, zu schaffen.

11. Luftfeder-Buchse nach Anspruch 10, bei der der Bandbereich (B-D,H-G,B-F) eine Einrichtung zum Bewirken einer ausgebeulten Kontur der Buchse (32,84) bildet.

12. Luftfeder-Buchse nach Anspruch 10, bei der sich der Bandbereich (E-B,H-G) in dem Kammer-Bereich (A-B) der Buchse (66,84) befindet.

13. Luftfeder-Buchse nach Anspruch 10, bei der sich der Bandbereich (B-D,B-F) in dem Rollbalg-Bereich (B-C) befindet.

14. Luftfeder-Buchse nach Anspruch 13, bei der sich der Bandbereich (B-D,B-F) in dem Rollbalg-Bereich (B-C) und dem Kammer-Bereich (A-B) benachbart befindet.

15. Luftfeder-Buchse nach einem der Ansprüche 10 bis 14, bei der der Bandbereich (B-D,E-B,H-G,B-F) axial zur Buchse eine Breite von mindestens etwa 1,27 cm (0,5 in) hat.

16. Luftfeder-Buchse nach Anspruch 10, bei der die Buchse (32,66) im wesentlichen zylindrisch ist.

17. Luftfeder-Buchse (94) nach Anspruch 10, bei der die Buchse im wesentlichen kegelstumpfförmig ist.

18. Luftfeder-Buchse nach einem der Ansprüche 10 bis 17, bei der die absolute Differenz zwischen den ersten und zweiten gegensinnigen Schraubenwinkeln mindestens etwa fünf Grad beträgt.

19. Luftfeder-Buchse nach Anspruch 10, bei der die inkonstanten Schraubenwinkel (48) des Bandes (B-D) im wesentlichen in dem Rollbalg-Bereich (B-C) angeordnet und von einem zweiten (M), gegensinnigen inkonstanten Schraubenwinkel in einem zweiten, im wesentlichen in dem Kammer-Bereich (A-B) befindlichen ringförmigen Bandbereich (E-B) gefolgt werden, wobei die gegensinnigen Schraubenwinkel des zweiten Bandbereiches (E-B) von den zweiten gegensinnigen Schraubenwinkeln (M) bis hin zu dritten gegensinnigen Schraubenwinkeln (L-L') verlaufen.

20. Luftfeder-Buchse nach Anspruch 19, bei der der erste gegensinnige Schraubenwinkel von etwa 30 bis etwa 45 Grad beträgt, der zweite gegensinnige Schraubenwinkel von etwa 40 bis etwa 55 Grad beträgt und der dritte gegensinnige Schraubenwinkel von etwa 30 bis etwa 45 Grad beträgt.

21. Luftfeder-Buchse nach Anspruch 10, bei der die Cords (36) in jeder der aufeinanderfolgenden Schichten (38,40) in dem Kammer-Bereich (A-B) mit einem ersten Schraubenwinkel (T) und in dem Rollbalg-Bereich (B-C) mit einem zweiten, ungleichen Winkel (T') gewickelt sind.

22. Luftfeder-Buchse nach Anspruch 21, bei der der Winkel in dem Kammer-Bereich (A-B) größer ist als der Winkel in dem Rollbalg-Bereich (B-C).

23. Luftfeder-Buchse nach Anspruch 22, bei der der erste Schraubenwinkel (T) im Bereich von etwa 10 bis etwa 89 Grad und der zweite Schraubenwinkel (T') im Bereich von etwa 30 bis etwa 62 Grad liegt.

24. Luftfeder-Buchse nach Anspruch 21, bei der der erste Schraubenwinkel (T) im Bereich von etwa 20 bis etwa 70 Grad und der zweite Schraubenwinkel (T') im Bereich von etwa 35 bis etwa 55 Grad liegt.

25. Luftfeder-Buchse nach Anspruch 21, bei der der erste Schraubenwinkel (T) im Bereich von etwa 30 bis etwa 60 Grad und der zweite Schraubenwinkel (T') im Bereich von etwa 38 bis etwa 55 Grad liegt.

26. Verfahren zum Herstellen einer Luftfeder-Buchse (32,66,84,94) durch Einbetten aufeinanderfolgender Schichten (38,40) von Cords (36) mit gegensinnigen Schraubenwinkeln (J-J',K-K') in ein Elastomer und Ausbilden eines Kammer-Bereiches (A-B) und eines Rollbalg-Bereiches (B-C) zwischen Endteilen (52,72;58,76), gekennzeichnet durch den folgenden Verfahrensschritt:
Wickeln von Cord (36) in aufeinanderfolgenden Schichten (38,40) in einem ringförmigen Band (B-D,E-B, H-G,B-F) eines der Buchsenbereiche (A-B,B-C) mit inkonstanten Schraubenwinkeln (48), von ersten gegensinnigen Schraubenwinkeln (J-J',L-L',M,P-P',R-R',T) bis hin zu zweiten gegensinnigen Schraubenwinkeln (K-K',M,N-N', R-R',S-S',T').

27. Verfahren nach Anspruch 26, mit dem Schritt des Wickelns des Cords (36) in dem Band (B-D,B-F) als Teil des Rollbalg-Bereiches (B-C).

28. Verfahren nach Anspruch 26, mit dem Schritt des Wickelns des Cords (36) in dem Band (E-B,H-G) als Teil des Kammer-Bereiches (A-B).

29. Verfahren nach Anspruch 26, mit dem Schritt des Wickelns des Cords (36) in einem zweiten Bandbereich (B-F) mit inkonstanten Schraubenwinkeln (48) von zweiten gegensinnigen Schraubenwinkeln (R-R') bis hin zu kleineren, dritten gegensinnigen Schraubenwinkeln (S-S').

30. Verfahren nach Anspruch 29, bei dem das Verfahren zum Herstellen der Buchse einschließt: Schichtung von Elastomer- und Cordmaterialien auf einem Dorn (102) und Einbetten aufeinanderfolgender Schichten von Cord (104) mit gegensinnigen Schraubenwinkeln in dem Elastomer, Härten der Buchse und Abnehmen des Dorns (102) unter Bildung eines Kammer-Bereiches (A-B) und eines Rollbalg-Bereiches (B-C), wobei das Verfahren ferner einschließt:
Bilden einer Reihe von mindestens zwei Ende an Ende miteinander verbundenen Buchsen; und
Trennen der Reihe von Buchsen in einzelne Buchsen (32,66,84,94).

31. Verfahren nach Anspruch 30, mit dem Schritt des Wickelns des Cords (36) in dem Band als Teil des Rollbalg-Bereiches (B-C) jeder Buchse (32,66,84,94).

32. Verfahren nach Anspruch 30, mit dem Schritt des Wickelns des Cords (36) in dem Band als Teil des Kammer-Bereiches (A-B) jeder Buchse (32,66,84,94).

33. Verfahren zur Beeinflussung der Federungsrate einer Luftfeder mit einer Buchse (32,66,84,94), mit (1) einem Kammer-Bereich (A-B) und (2) einem Rollbalg-Bereich (B-C), die zwischen Endteilen (52,72;58,76) angeordnet sind, welche mit Verschlußteilen (54,74;60,78) verbuttden sind, und einem Kolben (60,78), wobei die Buchse aus Elastomer besteht, das durch aufeinanderfolgende Schichten (38,40) aus eingebetteten Cords (36) verstärkt ist, welche mit gegensinnigen Schraubenwinkeln (J-J',K-K') angeordnet sind, gekennzeichnet durch die folgenden Verfahrensschritte:
Wickeln von Cord (36) aufeinanderfolgender Schichten in einem ringförmigen Bandbereich (B-D,E-B,H-G,B-F) eines der Buchsenbereiche (A-B,B-C) mit inkonstanten Schraubenwinkeln (48) von einem ersten Schraubenwinkel (J-J',L-L',M,P-P',R-R',T) bis hin zu einem zweiten Schraubenwinkel (K-K',M,N-N',R-R',S-S',T'), wobei die Differenz zwischen den ersten und zweiten Winkeln größer als fünf Grad und geringer als fünfundzwanzig Grad ist; und
Konturieren einer ausgebeulten Form der Luftbuchse (32,66,84,94) durch das ringförmige Band (B-D, E-B,H-G, B-F) zur Beinflussung der Federungsrate der Luftfeder.

34. Verfahren zur Beeinflussung der Federungsrate nach Anspruch 33, mit dem Schritt des Anordnens des Bandes (B-D,B-F) in dem Rollbalg-Bereich (B-C).

35. Verfahren zur Beeinflussung der Federungsrate nach Anspruch 33, mit dem Schritt des Anordnens des Bandes (E-B,H-G) in dem Kammer-Bereich (A-B).

36. Verfahren zur Beeinflussung der Federungsrate nach Anspruch 33, mit dem Schritt des Anordnens des Bandes (B-D,B-F) in dem Rollbalg-Bereich (B-C) und in der Nähe des Kammer-Bereiches (A-B) und des Wickelns des Cords (36) mit inkonstanten Schraubenwinkeln von einem ersten Winkel von etwa 40 Grad bis hin zu einem zweiten Winkel von etwa 50 Grad.

37. Verfahren zur Beeinflussung der Federungsrate nach Anspruch 33, mit den folgenden Verfahrenschritten:
Wickeln von Cord (36) aufeinanderfolgender Schichten in einem ringförmigen Bandabschnitt des Kammer-Bereiches (A-B) mit inkonstanten Schraubenwinkeln von einem zweiten Schraubenwinkel von etwa 50 Grad bis hin zu einem dritten Schraubenwinkel von etwa 40 Grad; und
Konturieren der ausgebeulten Gestalt des Kammer-Bereiches.

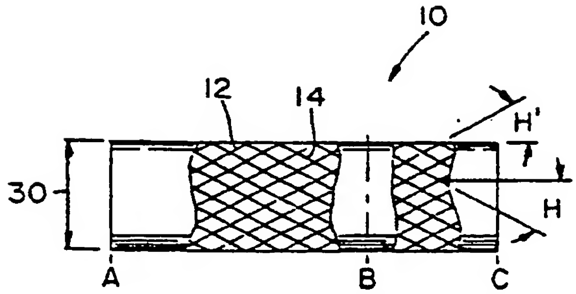


FIG. 1 (PRIOR ART)

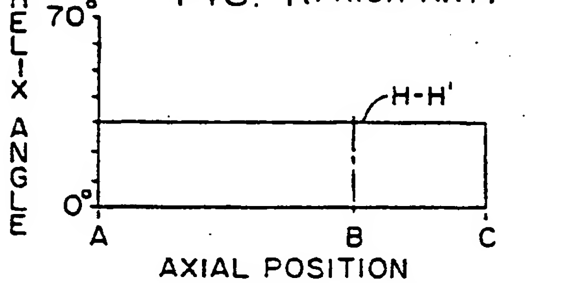


FIG. 2 (PRIOR ART)

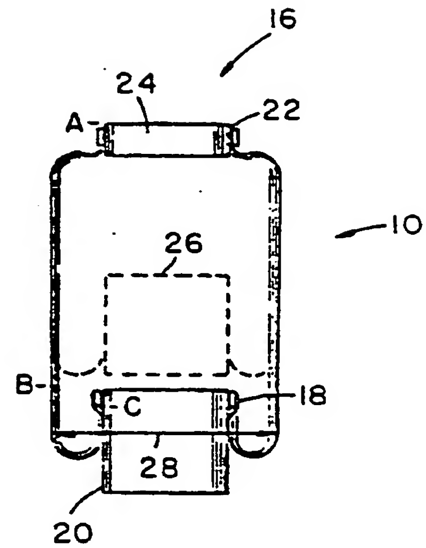


FIG. 3
(PRIOR ART)

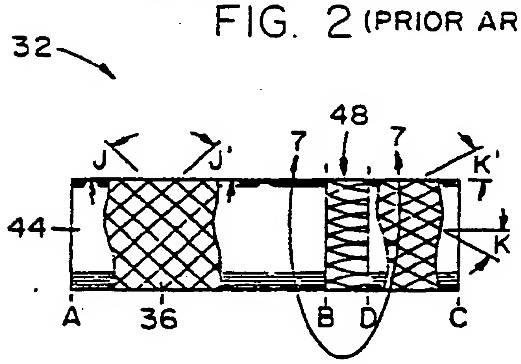


FIG. 4

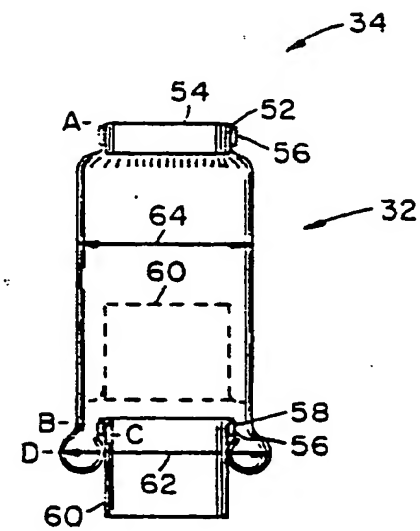


FIG. 6

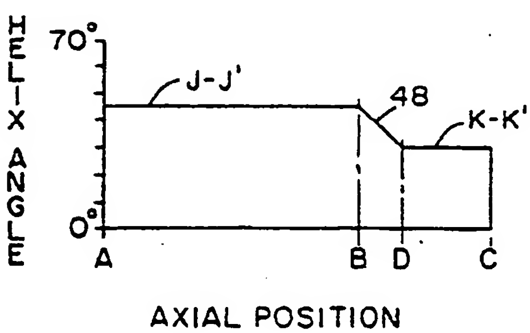


FIG. 5

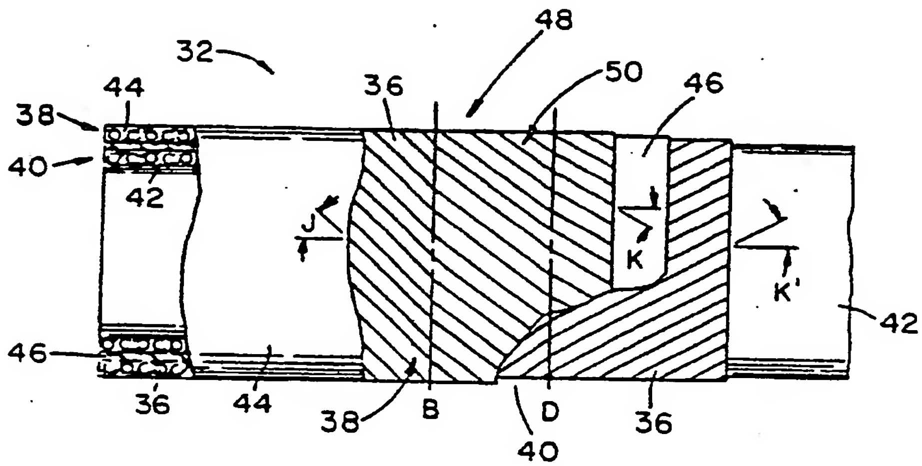


FIG. 7

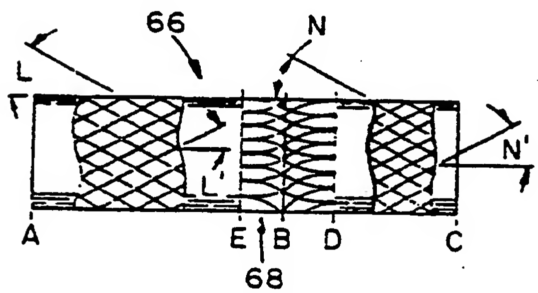


FIG. 8

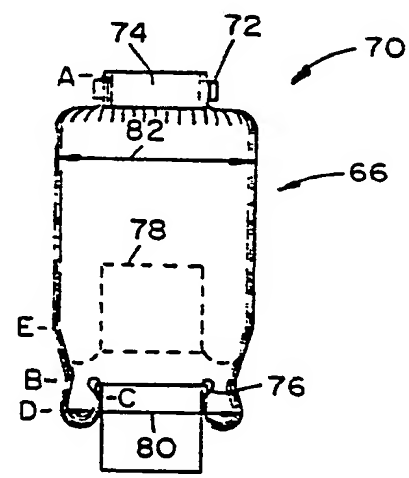


FIG. 10

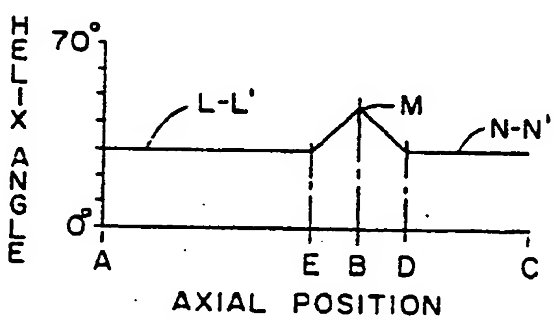


FIG. 9

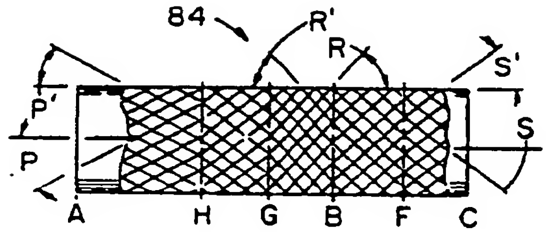


FIG. 11

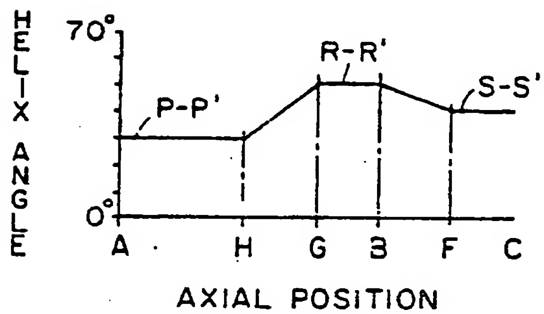


FIG. 12

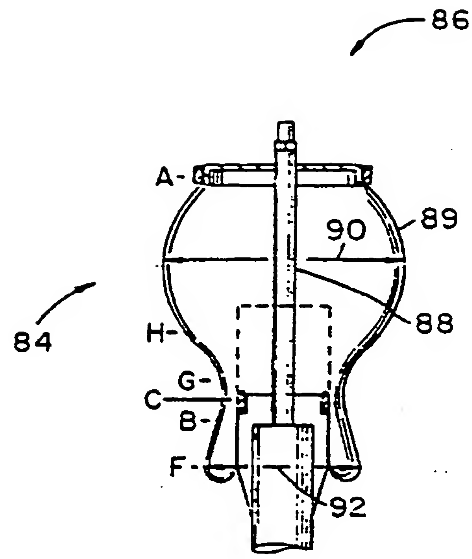


FIG. 13

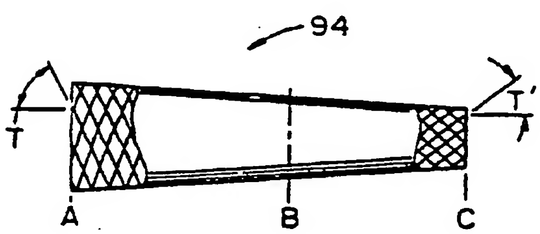


FIG. 14

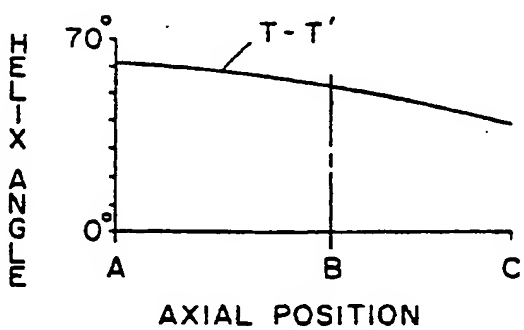


FIG. 15

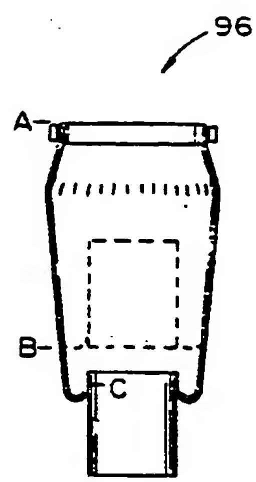


FIG. 16

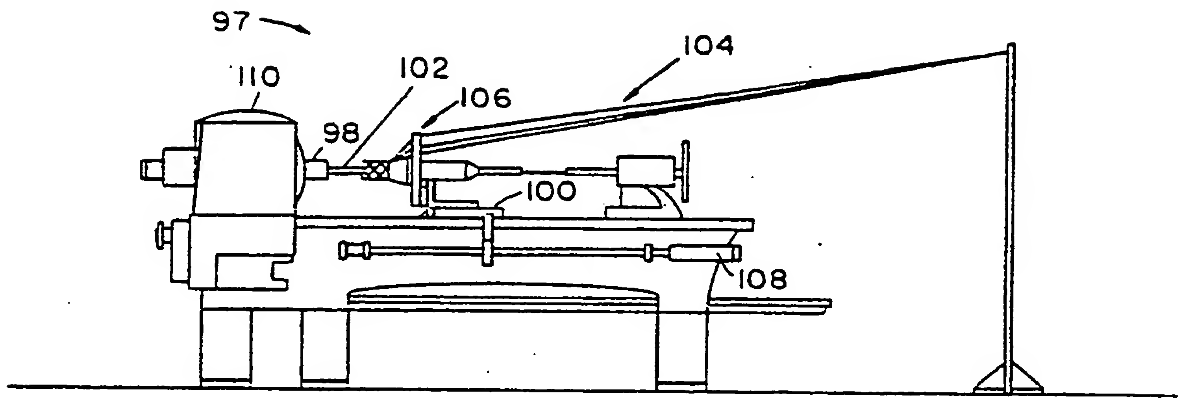


FIG. 17

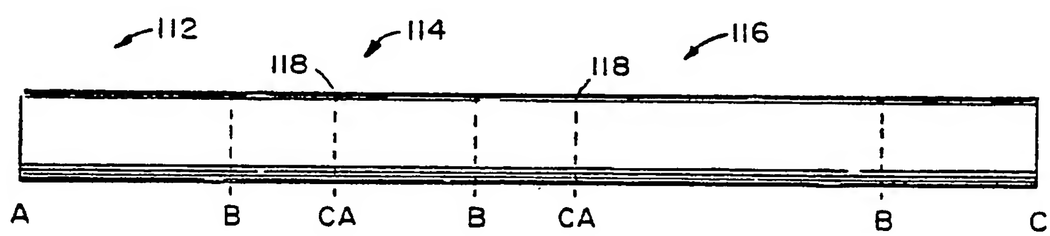


FIG.18

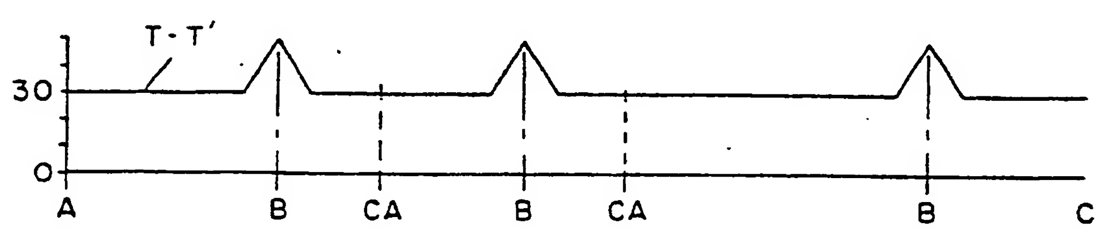
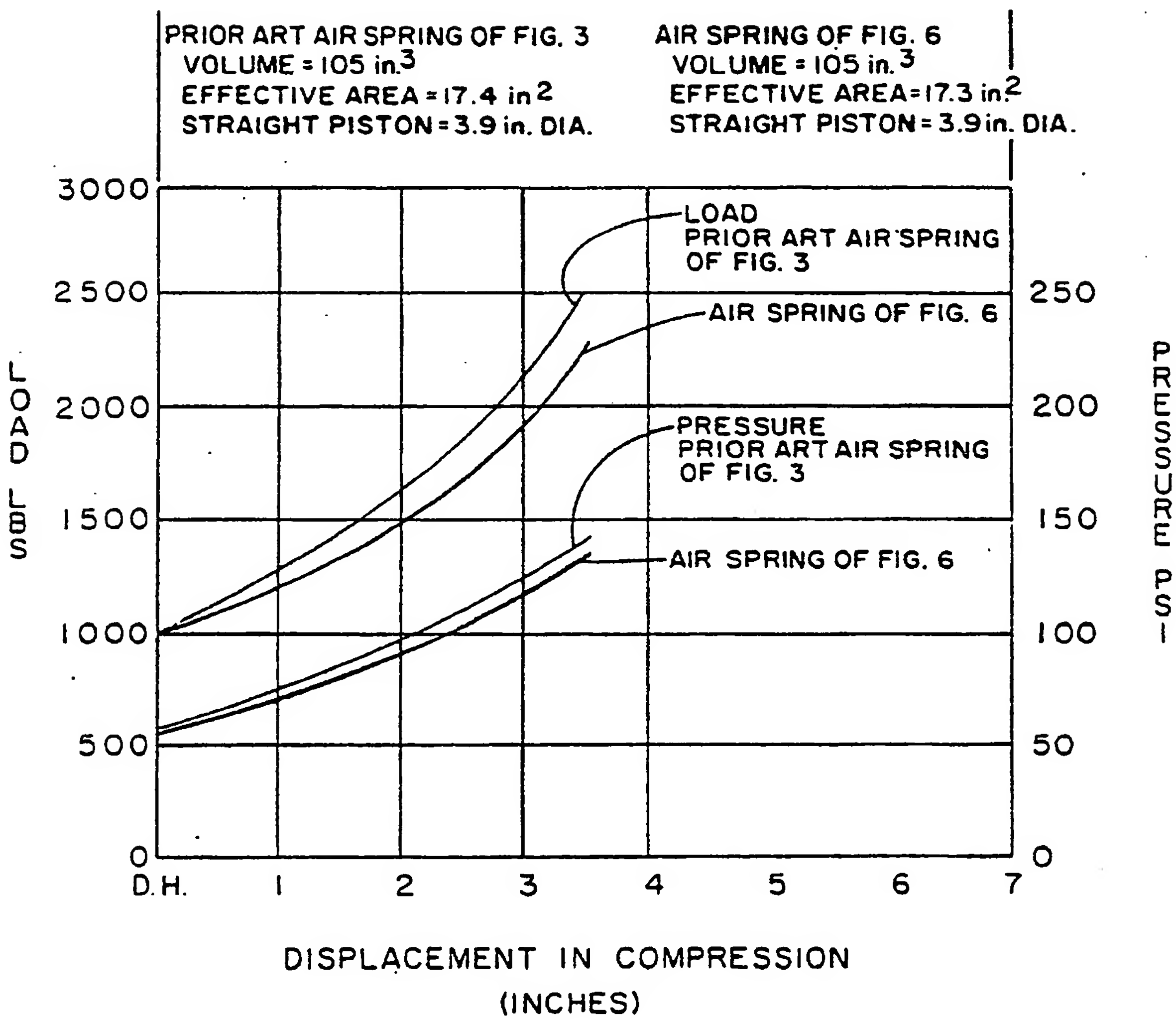


FIG. 19



PRIOR ART AIR SPRING OF FIG. 3
VOLUME = 105 in.^{3}
EFFECTIVE AREA = 17.4 in^2
STRAIGHT PISTON = 3.9 in. DIA.
AIR SPRING OF FIG. 6
VOLUME = 105 in.^{3}
EFFECTIVE AREA = 17.3 in.^{2}
STRAIGHT PISTON = 3.9 in. DIA.
LOAD PRIOR ART AIR SPRING OF FIG. 3
AIR SPRING OF FIG. 6
PRESSURE PRIOR ART AIR SPRING OF FIG. 3
AIR SPRING OF FIG. 6
LOAD LBS
PRESSURE PSI
3000
2500
2000
1500
1000
500
0
250
200
150
100
50
0
D.H.
1
2
3
4
5
6
7
DISPLACEMENT IN COMPRESSION (INCHES)

FIG. 20

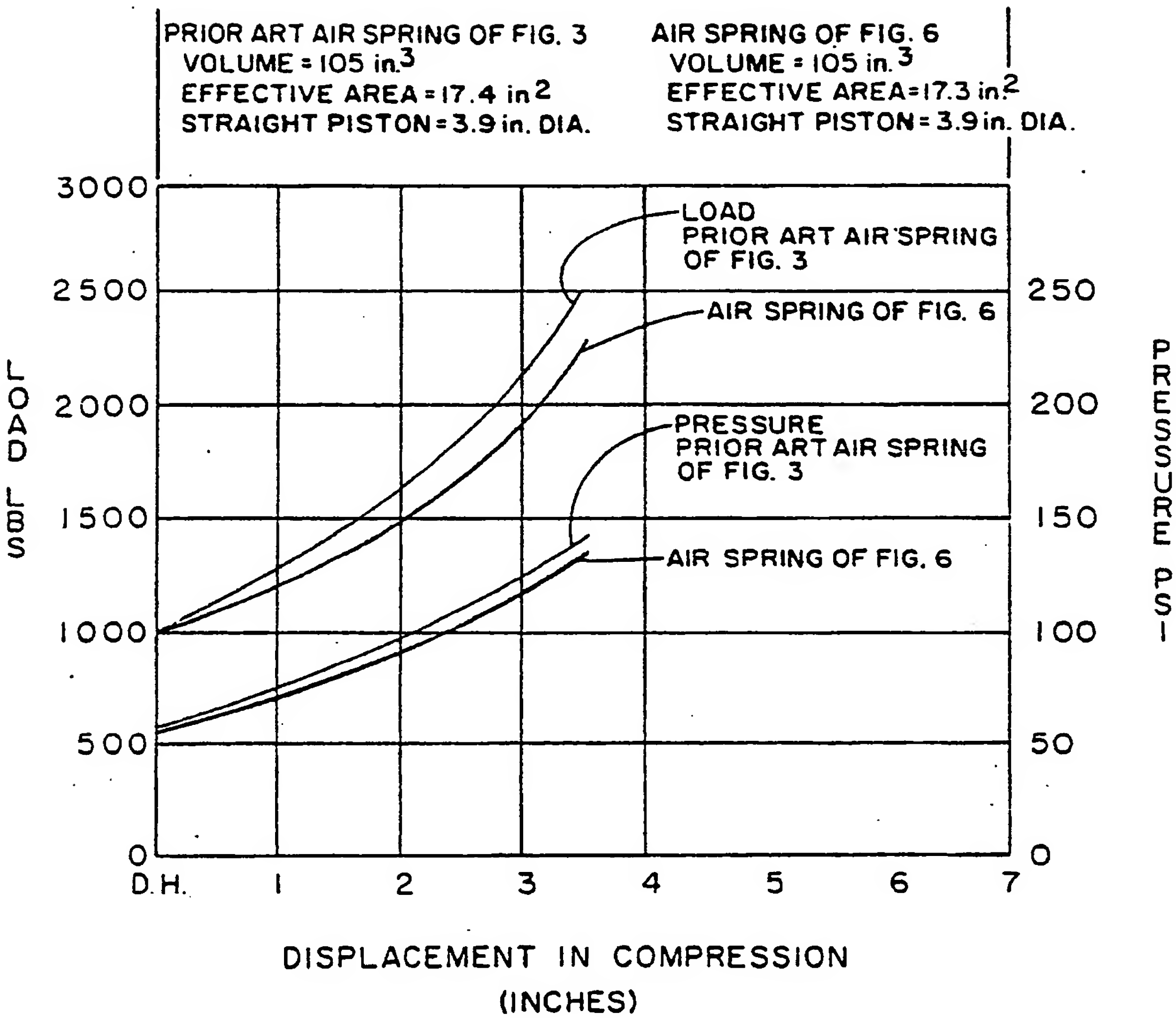

PRIOR ART AIR SPRING OF FIG. 3
VOLUME = 105 in.3
EFFECTIVE AREA = 17.4 in2
STRAIGHT PISTON = 3.9 in. DIA.
AIR SPRING OF FIG. 6
VOLUME = 105 in.3
EFFECTIVE AREA = 17.3 in2
STRAIGHT PISTON = 3.9 in. DIA.
LOAD
PRIOR ART AIR SPRING
OF FIG. 3
AIR SPRING OF FIG. 6
PRESSURE
PRIOR ART AIR SPRING
OF FIG. 3
AIR SPRING OF FIG. 6
LOAD LBS
PRESSURE PSI
3000
2500
2000
1500
1000
500
0
250
200
150
100
50
0
D.H.
1
2
3
4
5
6
7
DISPLACEMENT IN COMPRESSION
(INCHES)

FIG. 20